

**Part 1. Report Cover**

**Report Number:** 00AYP006      **Report Date(s):** 5 Sep 00

**Replacement Report Number(s):** AF69TR98032, 14 Aug 98

**Title:** Performance Oriented Packaging Testing of an  
MS27684 Removable Head Drum, 7-Gallon, With a 1-Quart,  
Rectangular, Plastic Bottles (Quantity of 4) for Liquids

**Responsible Individual:** Francis S. Flynn

**Performing Activity:** LOGSA Packaging, Storage,  
and Containerization Center  
ATTN: AMXLS-T  
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Tobyhanna, PA 18466-5097

**Performing Activity's Reference(s):** TE 35-97;  
AMC 13-88

**Report Type:** Interim      Final

**DTIC Distribution:** N/A

**Requesting Organization:**  
Defense Logistics Agency  
Defense Distribution Center  
ATTN: DDC-TO  
2001 Mission Drive  
New Cumberland, PA 17070

**Requesting Organization's Reference(s):**  
DLA Memo, 14 Oct 99

**Part 2. Test Results:** \_\_\_\_ single  X  combination \_\_\_\_ composite

### **Section I. Pre-test Conditions**

For initial testing, one drum was received in new condition.

The following identification schema designates the packaging specimen used for the test(s) indicated.

<u>Specimen No.</u>	<u>Test</u>
A	stack test
B	repetitive-shock vibration test
B	flat onto top, drop test
	flat onto bottom, drop test
	flat onto top circumferential chime, drop test
	flat onto bottom circumferential chime, drop test
	flat onto seam, drop test

### **Section II. Summary**

<b>A. Drop test - 1.8 m</b>	<b>PASS</b>
flat onto the top	PASS
flat onto the bottom	PASS
diagonally onto top circumferential chime	PASS
flat onto bottom circumferential chime	PASS
flat onto seam	PASS
<b>B. Leakproofness test -</b>	N/A
<b>C. Internal pressure test/Hydrostatic pressure test (liq.) -</b>	N/A
<b>D. Stacking test - static load, 1,500 lb, 24 hr</b> (tested under 00AYP013)	<b>PASS</b>
<b>E. Vibration standard - repetitive-shock, rotary motion</b> 3.75 Hz., 1 hr	<b>PASS</b>
<b>F. Water resistance test (fiberboard box) -</b>	N/A
<b>G. Compatibility test (liq. in plastics) -</b>	N/A

**Part 2. Test Results** (continued)**Section III. Discussion****A. Drop test:** 49 CFR §178.603

- ☒ cold conditioned (0° F, 72 hr)  
☐ ambient conditions ( ~72° F )  
☐ standard conditions (23° C & 50% RH)

No.	Ht.	Orientation	Results
B	1.8 m	Flat onto top	Pass/No leaks/rupture; entire contents retained
B	1.8 m	Flat onto bottom	Pass/No leaks/rupture; entire contents retained
B	1.8 m	Diagonally onto top circumferential chime	Pass/No leaks/rupture; entire contents retained
B	1.8 m	Diagonally onto bottom circumferential chime	Pass/No leaks/rupture; entire contents retained
B	1.8 m	Flat onto seam	Pass/No leaks/rupture; entire contents retained

For each orientation for the drop test, a free fall drop table, set for 1.8 meters (71 in.), was used. The impact surface was a ½-inch steel plate bolted to the concrete floor.

The decision to use the same container (configuration) for all five drop orientations was based on the relatively minimal damage demonstrated during previous testing of MS27684 drums with different inner containers or articles. Five drops per configuration exceeds 49 CFR §178.603 requirements, as well as both UN and ASTM recommendations (i.e., one drop on a side or circumferential chime per drum). The use of one configuration for multiple tests and drops is DOD policy as stated in DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/MCO 4030.40A, Packaging of Hazardous Material. Also per this policy, any failed orientation(s) can be repeated using another configuration.

**B. Leakproofness test:** 49 CFR §178.604

N/A. The leakproofness test of inner packaging is not required.

**C. Internal Pressure/Hydrostatic Pressure test:** 49 CFR §178.605

N/A. Testing for the maintenance of internal pressure is not required for combination configurations for surface modes.

**Part 2. Test Results: Section III** (continued)

**D. Stacking test:** See 49 CFR §178.606.

☐ standard conditions (23° C & 50% RH)

☒ ambient conditions ( ~72° F )

☐ high temperature conditions (104° F)

No.	Length	Type	Load/Force	Peak Force	Results	Stability Maintained?
A	24 hr	Static	1,500 lb	N/A lbf	Pass	Yes

A static top load (1,500 lbs) was used for the stack test, because it could hold the load constant for the required 24-hour timeframe. The total top load to be applied was greater than the minimum required for one drum based on the outside drum height and the gross packaged weight. The top load was to simulate a stack of identical packagings that might be stacked on the packaging during transport.

**E. Vibration test:** See 49 CFR §178.608.

No.	Frequency	Duration	Results
B	3.75 Hz	1 hr	Pass. No leakage, rupture, or damage

To be in compliance with U.S. Department of Transportation standards for packagings bearing the United States mark (USA) as a component of the packaging certification marking (49 CFR §173.24a(a)(5)), the vibration test was performed, as a means to determine capability. The test was conducted as prescribed by ASTM D 999, method A2 (Repetitive Shock Test (Rotary Motion)). The test was run for 1 hour, using the drum/plastic bottles combination packaging. The combination packaging was tested using a 2,000-lb vibration table (rotary motion) that had a 1-inch-vertical double amplitude (peak-to-peak displacement) such that the combination packaging was raised from the platform to such a degree that a piece of steel strapping (1.6 mm) could be passed between the bottom of the package and the platform.

**F. Water resistance (Cobb Method) test** (fiberboard): N/A.

The Cobb Method Test, addressed in (49 *CFR* §178.516), Standards for Fiberboard Boxes, is a material specification test only for the fiberboard to be used for outer packagings.

**G. Compatibility test** (plastics packagings only): N/A

Compatibility testing (a procedure specified in appendix B to part 173, as required by 49 *CFR* §173.24(e)(3)(ii)) is only required for plastics packagings intended to contain *liquid* hazardous materials.

### **Part 3. Test Personnel**

The personnel who performed the aforementioned testing, or had a role in the testing, evaluation, and/or documentation, as reported herein are recorded in the test files.

### **Part 4. References**

**A. Title 49 Code of Federal Regulations, Parts 106 and 180,** Spring 2000, current as of 14 Jan 00

**B. International Air Transport Association Dangerous Goods Regulations,** 40th edition, 1 January 1999

**C. ASTM D 4919,** Specification for Testing of Hazardous Materials Packagings.

**D. ASTM D 999,** Standard Method for Vibration Testing of Shipping Containers.

**E. ASTM D 951,** Standard Test Method Water Resistance of Shipping Containers by Spray Method.

**F. TAPPI Standard: T 441** Water Absorptiveness of Sized (Non-Bibulous) Paper and Paperboard (Cobb Test).

**G. Recommendations on the Transport of Dangerous Goods,** sixth revised edition, United Nations, New York, 1990.

H. DLAD 4145.41/AR 700-143/AFJI 24-201/NAVSUPINST 4030.55A/  
MCO 4030.40A, Packaging of Hazardous Material, 23 Jul 96

I. AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19G/DLAI4145.3,  
Preparing Hazardous Materials for Military Air Shipments, 1 Mar 97

**Part 5. Equipment**

Item	Manufacturer	Serial No.	Calibration Expiration Date
2,000-lb vibration table	L.A.B Skaneateles, NY	G23605	<i>see note</i>
5,000-lb compression tester	L.A.B Skaneateles, NY	1107050	4/01
drop tester	L.A.B Skaneateles, NY	3811	N/R
cold chamber	Russells Holland, MI	1962214	4/01

Note. Equipment is calibrated in accordance with International Safe Transit Association test equipment verification requirements.

## **Appendix A**

### **Test Applicability**

Pass/fail conclusions were based on the particular bottle and drum specimens, test loads, and the limited quantities submitted for test. Extrapolation to other materials, other manufacturers, other applications, different inner packagings, container sizes, or lesser inner quantities is the responsibility of the packaging design agency or applicable higher headquarters. Extrapolation of test results based on less than the minimum recommended number of test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

Reference to specification materials has been made based either on the information provided by the requester, the manufacturer, or the markings printed on, attached to, or embossed on the packagings. It was not possible to identify the exact composition of the drum construction materials.

Testing was performed per *Title 49 Code of Federal Regulations*.

Performance testing was undertaken and completed at the request of an agency responsible for shipment of the dangerous good(s). The completion of successful required performance tests does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

The required performance tests are intended to evaluate the performance of the packaging components. The criteria used to evaluate packaging performance is whether the contents of the packaging are retained within the outer packaging, should damage to the outer packaging occur, and secondly, if any inner packaging of hazardous materials leaks, ruptures, or is damaged so as to affect transportation safety. The successful completion of the required tests does not ensure the undamaged delivery or survivability of the actual commodity/item. Separate testing is necessary to assure the stability of any explosive item.

Before a configuration can be certified by the person(s) authorizing shipment, the appropriate packaging for the particular hazardous materials and mode of transportation must be determined, and the item(s) must be prepared for shipment per applicable regulations. The chosen configuration must have been performance tested in accordance with the size, the shape, and the weight constraints posed by the configuration to be certified. The testing reported herein

should not be construed as blanket certification of any configuration which simply uses the performance tested outer drum. Packaging paragraphs apply.

A-1

RN: 00AYP006

## **Appendix B**

### **Test Data Sheet**

#### **Section I. Test Product**

**Physical State:** \_\_\_ solid  X  liquid \_\_\_ gas \_\_\_ aerosol

**Amount Per Container:**

Item Weight-- 9.4 lbs. (4 ea. @ 2.35 lb)

Tare Weight-- 18.34 lbs.

Gross Weight-- 27.74 lbs.

**Gross Weight:**

**Density/Specific Gravity:** 1.05



**Appendix B (Continued)****Section II. Test Parameters (continued)****Stacking Weight Formula, Liquids - DLA**

Variables	Inputs	Calculations
h height, drum/box	20.5	
n # stacked containers	XXXXXXXXXX	5.76
w1 weight, drum/box	9.5	9.5
w2 weight, bottle/can	0.16	.64(4)
w3 weight, ring/pad	0	0
q1 # inner containers	4	4
v1 max. volume, 1 inner container	0.26	.26(1.04)
v total volume	XXXXXXXXXX	1.04
w4 weight, item (unpacked)	9.4	9.4(4)
W5 weight, absorbent	8.2	8.2
W total weight	XXXXXXXXXX	27.74
C constant	1	
A1 Stacking weight-PG I	XXXXXXXXXX	<b>180.4</b>
A2 Stacking weight-PG II	XXXXXXXXXX	<b>204.5</b>
A3 Stacking weight-PG III	XXXXXXXXXX	<b>240.8</b>
A11 Stacking weight, rounded-PG I	XXXXXXXXXX	<b>181</b>
A21 Stacking weight, rounded-PG II	XXXXXXXXXX	<b>205</b>
A31 Stacking weight, rounded-PG III	XXXXXXXXXX	<b>241</b>

**NOTE:** A1 =  $(n-1) \cdot (w + (1.2 \cdot v \cdot 8.3 \cdot 0.98)) \cdot (c)$ , Packing Group I  
A2 =  $(n-1) \cdot (w + (1.8 \cdot v \cdot 8.3 \cdot 0.98)) \cdot (c)$ , Packing Group II  
A3 =  $(n-1) \cdot (w + (2.7 \cdot v \cdot 8.3 \cdot 0.98)) \cdot (c)$ , Packing Group III

A1 = stacking weight in pounds, PG I  
A2 = stacking weight in pounds, PG II  
A3 = stacking weight in pounds, PG III

n =  $(118/h)$ , minimum number of containers that when stacked, reach a height of

3 m

w =  $w1 + (w2 \cdot q1) + (w3 \cdot q1) + w5$ , total weight in pounds

v =  $v1 \cdot q1$ , total volume

C = either 1.5 (the compensation factor that converts the static load of the

stacking test into a load suitable for dynamic compression testing),  
or 1.0 (static top load)

B-2

RN: 00AYP006

**Appendix B (Continued)**

**Section III. Equivalencies of Liquids**

	Specific Gravity see note 1	Total (Each) Amount per Container	Gross Weight (pounds) (kilograms)	
water*	1.05	9.4 lb(2.35)	27.74	12.61
PG I	1.2	11.28 lb(2.82)	29.62	13.46
PG II	1.8	16.92 lb(4.23)	35.26	16.03
PG III	2.7	25.36 lb(6.34)	43.70	19.86

Note 1. Equivalent specific gravity derived from drop height as follows-- PG factor x density (or SG) = drop height, thus

SG = drop height/PG factor (49 CFR §178.603)

PG I: 1.5 m x SG = 1.8 m, thus SG = 1.2

PG II: 1.0 m x SG = 1.8 m, thus SG = 1.8

PG III: 0.67 m x SG = 1.8 m, thus SG = 2.7

Unless otherwise computed for more dense liquids, water (SG = 1) represents a solution having a specific gravity of 1.2 or less.

\*50% propylene glycol and 50% water solution

B-3

RN: 00AYP006

## **Appendix C**

### **Packaging Data Sheet**

#### **Section I. Exterior Shipping Container**

Packaging Category: \_\_\_\_ single X combination \_\_\_\_ composite

UN Type: Steel openhead drum (49 CFR §178.504)

UN Code: 1A2

Nominal (Rated) Capacity: 7 gal

UN Marking(s) on Packaging:

Label on drum side-- UN1A2/X120/S/99  
USA/M-2072

Specification Type and No(s): MIL-D-6054

Type/Materials: steel, open head drum, round, sponge gasket

Manufacturer/Distributor: MIRAX Chemical Products Corp.,  
ST. Louis, MO 63191  
CAGE 85717

Date(s) of Manufacture: 98 (embossed on drum bottom)

Nomenclature: Drum, Steel, Shipping and Storage (label marking)

NSN: 8110-00-254-5714 (drum assembly)

Tare Weight (empty drum): 9.5 lb (includes cover, ring, and bolt)

Dimensions:

20½ in. OD (drum height, including locking ring)

11½ in. OD (drum body diameter, outside ring)

10.5 in. ID (drum body diameter)

18.74 in. ID (drum body height)

Closure (Method/Type): Locking ring; nut and bolt, tightened to 6 ±  
½ foot-pounds

Closure Specification Number(s):

MS27684-31 (locking ring, style 1) NSN 8110-00-190-9992

MS27684-25 (gasket) NSN not assigned

MS27684-21 (drum cover, style 1) NSN 8110-00-841-1634

**Appendix C** (Continued)

**Section I. Exterior Shipping Container** (continued)

Closure Manufacturer: Locking ring-- not identified as being  
different from the drum manufacturer;  
nut & bolt-- not marked

Cushioning/Dunnage: cellulose fiber [approx. 8.2 lb]

Cushioning/Dunnage Specification Type(s):  
Cellulose fiber-- proprietary

**Additional Description:**

a. Approximately 6 inches of firmly-packed, loose-fill absorbent cushioning was placed in the bottom of the drum. Four bottles were placed on the absorbent. More loose-fill absorbent was then firmly packed around, and over the bottles. Approximately 1½ inches of loose-fill absorbent separated the bottles from the sides of the drum. The loose-fill absorbent must be firmly packed, especially toward the drum bottom chime. To pack the loose-fill absorbent, the use of a tamping stick is recommended.

b. The quantities of absorbent material do meet the 1-gallon guidelines for absorbent material outlined in AFJMAN 24-204/TM 38-250/NAVSUP PUB 505/MCO P4030.19F/DLAM 4145.3, Preparing Hazardous Materials for Military Air Shipments.

c. For this configuration, either firmly-packed, fine grade vermiculite or either of the following, firmly-packed cellulose fiber absorbent products, "HAZMATPAC® Absorbent A-900" or "Absorption Corporation Absorbent GP", can be used without any notable difference in performance. Inner packagings have a tendency to migrate if the loose fill material is not firmly packed, especially along the bottom chime.

**Appendix C (Continued)****Section II. Inner Packaging/Article**

Quantity of Inner Containers: 4 Capacity: 1 gallon

Specification Type and No(s): N/A

Type: Rectangular, plastic, screw-cap bottle with handle

Manufacturer/Distributor: Codes embossed on bottom not discernable

Material(s): Plastic Date(s) of Manufacture: N/A

NSN: N/A

Tare Weight (empty bottle): .16 lbs

Item Weight: 2.35 lb ea Filled Weight: 2.51 lbs. ea

Dimensions: 9 in. high x 3½ in. wide x 2½ in. diameter

Closure (Method?Type): Plastic screw cap, polyseal-24

Closure Specification Number(s): N/A

Closure Manufacturer: N/A

Closure Dimensions: 1¼ in. in diameter (OD)  
1 in. in height (OD)

Secondary Closure: Filament-reinforced tape (1 pc)

Secondary Closure Specification(s):

- (1) Tested (marked)-- Commercial Item Description Tape,  
Pressure-Sensitive Adhesive, (Medium Tensile Strength,  
Glass Filament, Reinforced Tape) [canceled Jan 96]
- (2) Equivalent to-- FED SPEC  
Tape, Packaging/Industrial, Filament Reinforced  
[canceled Jan 96]
- (3) Equivalent to-- ASTM Standard Specification for  
Pressure-Sensitive Tape for Packaging, Filament-Reinforced

Secondary Closure Specification Number(s): NSN-- 7510-00-582-4772

- (1) A-A-1687B, Amendment 1 (marked) [canceled Jan 96]
- (2) PPP-T-97, type II (medium tensile),  
class B (transparent) [canceled Jan 96]
- (3) ASTM D 5330-93, type II (medium tensile)

Secondary Closure Dimensions: 1 inch wide

C-3

RN: 00AYP006

## **Appendix D**

### **Rationale**

The equivalent of Packing Group I (great danger) testing was requested for a 7-gallon, steel, open head drum, having as the intended contents 1-quart, rectangular, plastic bottles, with screw caps. The configuration to be tested is intended to be applicable to a large assortment of liquid products contained in screw-cap, rectangular, plastic bottles, in volumes of 1-quart, 1-pint, or less. For lesser volumes, variations to testing requirements can be found in 49 CFR §178.601(g). This report is not applicable to 1-gallon bottles.

For testing, substitution for the actual hazardous lading is permitted by 49 CFR §178.602(c). Water can be used as a substitute liquid.

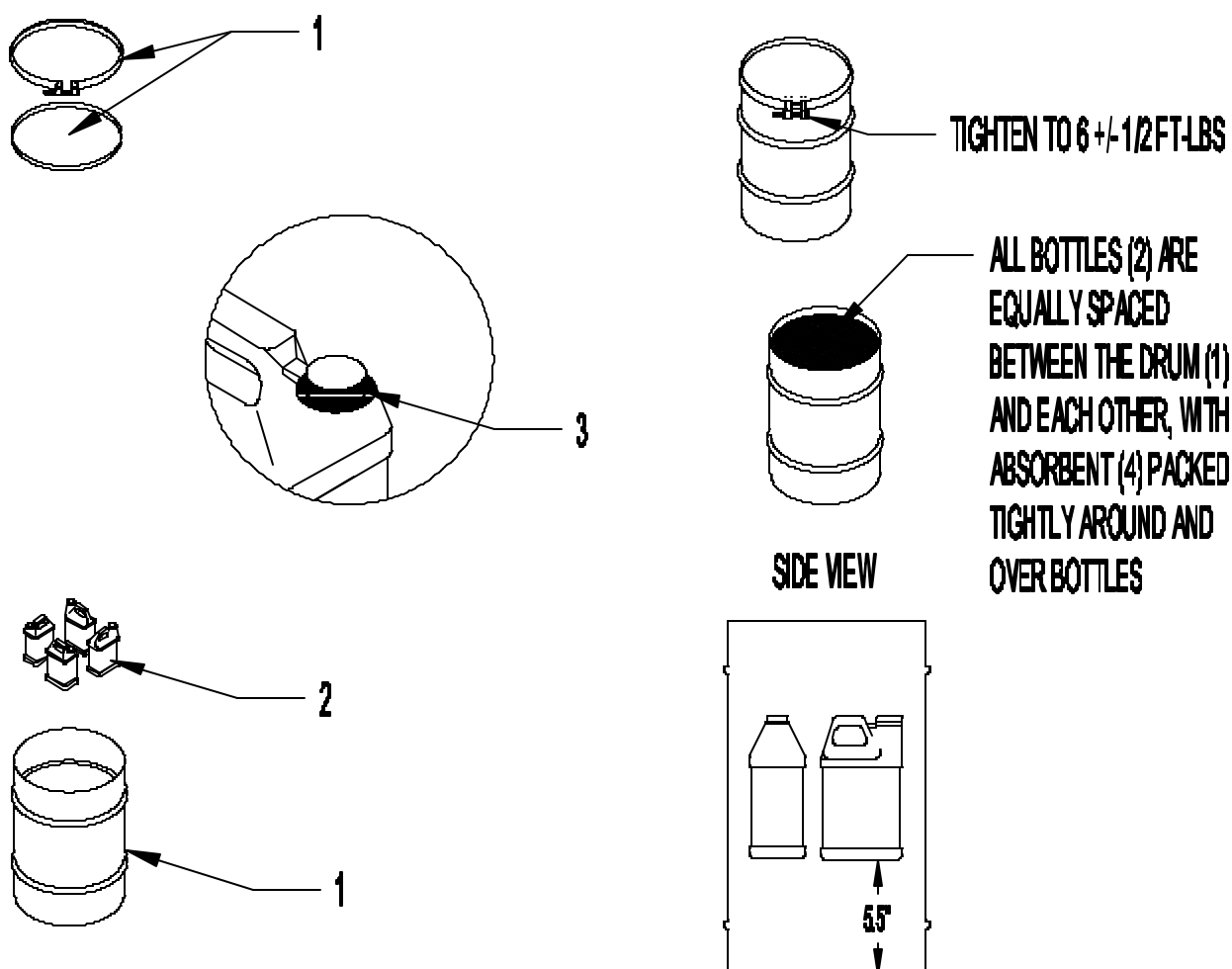
Per the requesting activity, cellulose fiber was used as an absorbent material and/or cushioning.

A bottle secondary closure utilizing filament-reinforced tape was used in accordance with accepted packaging practice.

One combination packaging, made to the above described configuration with 1 bottle, was initially subjected to drop and vibration testing as prescribed in ASTM D 4919. These tests are designed to simulate the shock and vibration a package (configuration) may encounter when being shipped worldwide by truck, rail, or ocean going transport. The order of testing was vibration, then drop testing. Prior to the rough handling testing of the packed drum, static loading was performed on the empty drum. This is a U.S. DOT approved method of stack testing, especially when the combination packaging has wide applications.

D-1  
**Appendix D (Continued)**  
**Drawing**

RN: 00AYP006



ITEM	DESCRIPTION	00AYP006D
1	7-GAL, DRUM, METAL-SHIPING & STORAGE, OPEN HEAD, IAW MIL-D-6054, NSN: 8110-00-254-5714, MS27684-5	
2	1-QUART, RECTANGULAR PLASTIC BOTTLE W/SCREW CAP, QTY. 4	
3	1-INCH WIDE, PRESSURE-SENSITIVE TAPE, FILAMENT-REINFORCED, IAW ASTM D 5330, TY II	
4	CELLULOSE FIBER ABSORBENT, OR VERMICULITE, A-A-52450	



